CLAIMS

1. A lubricant-feed-state monitoring sensor disposed directly to a device that needs to be fed with oily or fatty lubricant or to a lubricant feed pipe for feeding lubricant to the device, for monitoring the feed state of lubricant by detecting the supply of the lubricant to the device, the sensor comprising a detection member disposed in such a manner that a first end is fixed and a second end is positioned in the flow of lubricant produced when the lubricant is fed, the detection member undergoing bending deflection by the displacement of the second end due to the flow of the lubricant, and the detection member having a piezoelectric element that generates voltage by the bending deflection.

2. The lubricant-feed-state monitoring sensor according to Claim 1, wherein the detection member further comprises a coating member made of a flexible material that coats the piezoelectric element.

3. The lubricant-feed-state monitoring sensor according to Claim 1, wherein the detection member further comprises a reinforcing member that sandwiches the piezoelectric element, and a coating member made of a flexible material that coats the reinforcing member.

4. The lubricant-feed-state monitoring sensor according to one of Claims 1 to 3, further comprising a T-shaped member having a lubricant passage connected to the lubricant feed pipe and a detection member insertion portion extending vertically from the middle of the lubricant passage, into which the detection member is inserted, wherein the first end of the detection member is fixed to the top of the detection member insertion portion, and the second end is positioned in the lubricant passage without restraint.

5. A lubricant-feed-state monitoring device, comprising:

a sensor disposed directly to a device that needs to be fed with oily or fatty lubricant or to a lubricant feed pipe for feeding lubricant to the device, for monitoring the feed state of lubricant by detecting the supply of the lubricant to the device; and

a count unit that counts the number of feedings of lubricant to the device on the basis of a detection signal output from the sensor, wherein

the sensor includes a detection member disposed in such a manner that a first end is fixed and a second end is positioned in the flow of lubricant produced when the lubricant is fed, the detection member undergoing bending deflection by the displacement of the second end due to the flow of the lubricant, the detection member having a piezoelectric element that generates voltage by the bending deflection; and the counter unit counts the number of feedings of lubricant on the basis of a voltage pulse of a detection signal output as voltage from the piezoelectric element.

6. A lubricant-feed-state monitoring sensor disposed directly to a device that needs to be fed with lubricant or to a lubricant feed pipe, for detecting the feed state of lubricant to the device, the sensor comprising: a member that undergoes bending deflection by the lubricant flow when the lubricant is fed; signal conversion means that senses the strain of the member generated due to the bending deflection and converts the strain to an electrical signal; and pipe joint means for connecting to the lubricant feed pipe disposed so that the member undergoes the bending deflection due to the lubricant flow, the pipe joint means having a retaining seal structure for retaining the disposed member and preventing the leakage of the lubricant.

7. The lubricant-feed-state monitoring sensor according to Claim 6, wherein the pipe joint means is configured of one of a T-shaped pipe joint, a Y-shaped pipe joint, a cross pipe joint, an elbow, and a bend.

8. A lubricant-feed-state monitoring device, comprising the lubricant-feed-state monitoring sensor according to Claim 6 or 7; and a counter unit that counts the number of feedings of lubricant on the basis of an electrical signal converted from the bending strain of the member when the lubricant is fed, the signal being output from the signal conversion means.

9. The lubricant-feed-state monitoring device according to Claim 8, wherein the counter unit is disposed rotatably to the pipe joint means.

10. The lubricant-feed-state monitoring device according to Claim 8, wherein the counter unit is disposed detachably to the pipe joint means.

11. The lubricant-feed-state monitoring device according to Claim 8, wherein the counter unit connects to the pipe joint member via a flexible tube.

12. The lubricant-feed-state monitoring device according to Claim 10 or 11, wherein the counter unit comprises clamp means or attracting means.

13. The lubricant-feed-state monitoring device according to one of Claims 6 to 12, further comprising date setting means capable of setting and displaying date including at least month and day.

14. The lubricant-feed-state monitoring device according to Claim 13, wherein the counter unit comprises reset means for resetting the count.

15. The lubricant-feed-state monitoring device according to one of Claims 8 to 14, wherein the counter unit comprises a timer unit that generates signals at regular intervals and an alarm unit that generates an alarm when the number of lubricant feedings detected in the interval is smaller than a predetermined number of lubricant feedings.

16. The lubricant-feed-state monitoring device according to one of Claims 8 to 14, wherein the counter unit comprises an alarm unit that takes in a signal indicative of the operation of a distributing valve upstream in the lubricant feed pipe as a lubricant feed signal, and generates an alarm when there is no output indicative of lubricant feeding from the lubricant-feed-state monitoring device or when the output is small in a given period of time after the lubricant feed signal has been detected.

17. The lubricant-feed-state monitoring device according to one of Claims 8 to 14, wherein the counter unit comprises an alarm unit that takes in a start-up signal of a lubricant feed pump that pumps lubricant to the lubricant feed pipe as a lubricant feed signal, and generates an alarm when there is no output indicative of lubricant feeding from the lubricant-feed-state monitoring device or when the output is small in a given period of time after the lubricant feed signal has been detected.

18. The lubricant-feed-state monitoring device according to one of Claims 15 to 17, wherein the alarm unit generates an alarm by at least one of sound, light, and mechanically retained indication.

19. The lubricant-feed-state monitoring device according to one of Claims 15 to 18, wherein the counter unit comprises a radio unit that takes in at least one of the signal output from the signal conversion means, the count signal indicative of the number of lubricant feedings, the operation signal of the distributing valve, the start-up signal of the lubricant feed pump, and the alarm signal from the alarm unit and transmits the signal by radio.

20. The lubricant-feed-state monitoring device according to one of Claims 15 to 18, wherein the counter unit comprises a data collection unit that takes in at least one of the signal output from the signal conversion means, the count signal indicative of the number of lubricant feedings, the operation signal of the distributing valve, the start-up signal of the lubricant feed pump, and the alarm signal from the alarm unit; and a transmission unit that transmits the collected data via cable, radio, telephone line, or LAN.

21. The lubricant-feed-state monitoring sensor or device according to one of Claims 6 to 20, wherein the member is a piezoelectric element serving also as the signal conversion means.

22. The lubricant-feed-state monitoring sensor or device according to one of Claims 6 to 20, wherein the member is formed in such a manner that a piezoelectric element serving also as the signal conversion means is coated with a coating member.

23. The lubricant-feed-state monitoring sensor or device according to one of Claims 6 to 20, wherein the member is formed in such a manner that a piezoelectric element serving also as the signal conversion means and a contact member that is in contact with the piezoelectric element are coated with a coating member.

24. The lubricant-feed-state monitoring sensor or device according to one of Claims 6 to 20, wherein the signal conversion means is a strain gauge.

25. The lubricant-feed-state monitoring device according to Claim 24, wherein the member includes the strain gauge.

26. A method of monitoring the feed state of lubricant to a device that needs to be fed with the lubricant using a sensor that is mounted to the device or a lubricant feed pipe connected to the device, the method comprising:

disposing the sensor so as to undergo bending deflection by the lubricant flow when the lubricant is fed; converting the strain generated by the sensor owing to the bending deflection due to the lubricant flow to an electrical signal; counting the number of lubricant feedings to the device that needs to be fed with lubricant on the basis of the electrical signal; and when the counted number of lubricant feedings falls below a predetermined number of lubricant feedings in a given period of time, determining that the lubricant feed state is abnormal.

27. A method of monitoring the feed state of lubricant to a device that needs to be fed with the lubricant using a sensor that is mounted to the device or a lubricant feed pipe connected to the device, the method comprising:

disposing the sensor so as to undergo bending deflection by the lubricant flow when the lubricant is fed; converting the strain generated by the sensor owing to the bending deflection due to the lubricant flow to an electrical signal; measuring the peak voltage of the electrical signal by peak hold processing of the electrical signal; and when the peak voltage comes out of a predetermined range, determining that the lubricant feed state is abnormal.

28. The method of monitoring the feed state of lubricant according to Claim 27, wherein a lower threshold and a upper threshold are set for the peak voltage in advance; and when the peak voltage falls below the lower threshold, it is determined that the amount of lubricant has decreased or stopped, and when the peak voltage exceeds the upper threshold, it is determined that the part downstream from the sensor is clogged.

29. The method of monitoring the feed state of lubricant according to one of Claims 26 to 28, wherein a piezoelectric element is used for the sensor.

30. The method of monitoring the feed state of lubricant according to Claim 26, wherein when a piezoelectric element is used as the sensor, the capacitance of the sensor is measured after the monitoring of the lubricant feed state has been started, and when the capacitance becomes smaller than a predetermined threshold, it is determined that the sensor is abnormal, and abnormality owing to the abnormal sensor is removed from the determination on abnormality based on the count of lubricant feedings, on the basis of the determination on the sensor abnormality.

31. The method of monitoring the feed state of lubricant according to Claim 27 or 28, wherein when a piezoelectric element is used as the sensor, the capacitance of the sensor is measured after the monitoring of the lubricant feed state has been started, and when the capacitance becomes smaller than a predetermined threshold, it is determined that the sensor is abnormal, and abnormality owing to the abnormal sensor is removed from the determination on abnormality based on the peak voltage, on the basis of the determination on the sensor abnormality.

32. The method of monitoring the feed state of lubricant according to one of Claims 26 to 31, wherein a piezoelectric element coated with a coating member is used as the sensor.

33. The method of monitoring the feed state of lubricant according to one of Claims 26 to 32, wherein a piezoelectric element coated with a coating member and a contact member in contact with the piezoelectric element are used as the sensor.

34. The method of monitoring the feed state of lubricant according to one of Claims 26 to 28, wherein a strain gauge is used as the sensor.